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SHELL-FISH AND PUBLIC HEALTH

Adapted from an article called "Effects of Marine Sewage Disposal" by E.B. Pike and A.L.H. Gameson which appeared in "Water Pollution Control" Vol. 69, 1970, № 4, pp. 355-382. Notes on Pacific conditions by A.L. Thorstensen, Public Health Engineer, South Pacific Commission.

Fish or shell-fish taken from a polluted marine environment may be contaminated with sewage bacteria, and possibly potential pathogens, and these organisms can be present in the product when it reaches the consumer. The risk of infection can be eliminated if shell-fish are heat-treated or cooked sufficiently to destroy pathogens and if they are subsequently handles hygienically. However, some bivalve molluscs are normally eaten raw or only lightly cooked and the risks are therefore greater, as is indicated by past records of disease in which shell-fish have been involved.

The most important diseases which have been transmitted by shell-fish are typhoid and paratyphoid fevers, and more recently, infectious hepatitis. In addition, gastro-enteritis of non-specific origin sometimes occurs.

Salmonellae, the genus of bacteria causing typhoid and paratyphoid fevers, food poisoning (salmonellosis), and gastro-enteritis, have been isolated from many kinds of shell-fish taken from polluted waters in different countries. In certain Italian coastal towns, the continued presence of endemic typhoid is believed to be due to the indiscriminate consumption of grossly polluted shell-fish, and it is possible that a comparable situation exists on Tonga and Western Samoa, where the principal mode of transmission of typhoid fever is thought to be by food rather than by water.

Infectious hepatitis is the only virus disease at present attributed to shell-fish consumption, and outbreaks have occurred in Sweden and America after the consumption of grossly polluted oysters and hard clams. Because of technical difficulties, the virus of infectious hepatitis has not yet been isolated from polluted shell-fish, but other enteroviruses have been isolated from mussels and oysters.

The risks associated with the consumption of molluscan shell-fish arise from several factors. These species are usually found in estuaries, on fringing reefs, or in other parts of the coastal region where conditions favour their growth and reproduction; such areas are usually more heavily polluted than the open sea. Furthermore, oysters, mussels, cockles, clams and scallops are filter-feeders, that is, they feed by removing suspended material from a current of sea water propelled by ciliary activity through the gills. The filtration rate, and hence the level of pollution acquired, varies with the species and size of the shell-fish, and also with salinity and water temperature, this last being the major factor. Recorded filtration rates vary between 0.5 and 15.0 1/h for various species.

During the filtration process some 5 to 30 per cent of the suspended bacteria are retained, and these, together with other particles, pass through the alimentary tract. Thus, in bivalves taken from polluted waters, faecal bacteria are found in the shell fluid, on the surfaces of the gills, and in the alimentary tract. None is found within the tissues. Since the digestive diverticulum is the largest organ of the gut, more appear to be present there than elsewhere.

Despite the low efficiency of retention of bacteria, at higher water temperatures the concentration of faecal bacteria present in bivalves is considerably greater than that in the surrounding water. At 16° C the concentration of the faecal bacteria E. Coli in European flat oysters may be over 30 times that in the surrounding sea water, whereas at 4° C (because of the reduced activity) the concentration in the oyster may be only half that in the water. In Europe with its wide range of coastal water temperatures, there is accordingly a seasonal variation in levels if pollution reached by bivalves, and it has been shown that the logarithm of the E. Coli content of European oysters and of hard clams, is directly related to the water temperature.

The implications of this relationship in the South Pacific region are two:

1. That the concentration of enteric bacteria in oysters and clams in polluted sea water will be very much higher here than in Europe; and

2. That the level of concentration will be substantially constant throughout the year.

Extrapolating the relationship to a temperature range of 25-30° C typical of the South Pacific, results in a concentration factor in the range 500-3,500. This in turn suggests that oysters and clams in tropical waters may harbour pathogenic bacteria at all times of the year in numbers over 100 times as large as those found in shell-fish in comparably polluted water in temperate regions, with a consequential higher potential for the transmission of enteric diseases. Thus the relative freedom from marine sewage pollution enjoyed by most Pacific territories may well be negated as far as public health is concerned, by the greater capacity of shell-fish in the region to concentrate pathogenic bacteria. It should be noted that this temperature-concentration effect is less obvious in mussels than in oysters and clams.

At high water temperatures, oysters and mussels quickly reflect the bacteriological quality of the water in which they are living. In estuaries and on reefs subjected to pollution which varies with the direction of tidal flow, oysters and mussels can change from a condition of gross pollution to a state where they are suitable for human consumption within a matter of hours.

There is evidence that virus particles are concentrated by shell-fish in a manner similar to faecal bacteria. In one laboratory study the virus content of drained oyster meats reached 10-60 times that of the surrounding sea water, and in another the concentration capability of shell-fish varied inversely with the virus concentration in the water. This latter characteristic, superposed on the temperature-concentration effect, emphasises again the danger in tropical climates of assuming the shell-fish are fit for human consumption because they have been taken from areas where the level of pollution is apparently low.

It has been shown that the consumption of certain shell-fish from polluted waters, particularly filter-feeding bivalve molluscs which may be eaten in the raw or partly-cooked state, carries definite health risks. Although readily contaminated, shell-fish may be made suitable for human consumption by a number of processes, depending upon the species. Heat treatment, sufficient to kill faecal organisms, is of universal application. Immersion in purification tanks of clean sea water to allow self-cleansing to occur is less effective. A preferable procedure for bivalve shell-fish is that used extensively in Europe for mussels and oysters, in which shell-fish are held for 48 hours in tanks of sea water previously sterilized by chlorination or ultra-violet irradiation. The latter technique has little relevance in the South Pacific, but chlorination is readily effected simply by adding a very small quantity (1 oz in 1,000 gallons or 6g/m3) of dry calcium hypochlorite.

A more convenient method for use on a domestic scale is to use household chlorine bleach which has a strength of about 5% available chlorine. The method is as follows: Half fill a clean 44 gallon (200 litre) drum with clean sea water. If sea water is not conveniently available, it may be simulated by adding 6½ lbs (3 kilos) of ordinary household salt to 22 gallons (100 litres) of clean fresh water in the drum. Disinfect the water by adding 1 large teaspoonful (6 ml) of household chlorine bleach and stir in thoroughly. Add shell-fish which have first been washed to remove mud or sediment and leave undisturbed in a cool place for 24 hours. This method has the advantage that the shell-fish also cleanse themselves of sand and other detritus, and the contents of the alimentary tract. They can be kept for at least 48 hours in this fashion.

Footnote

In addition to the effects of established pathogenic organisms on shell-fish, sewage may affect fish and shell-fish in other ways, particularly when it contains industrial wastes. Thus petro-chemicals, and phenolic compounds may taint fish and shell-fish and make them unsuitable for human consumption. Molluscs and crustacea may accumulate certain pesticides which may be derived from industrial wastes, or from dumped domestic sludge which is known to contain quantities of these substances.

Certain heavy metals (copper and zinc) may make shell-fish unpalatable, whilst organic mercury compounds used industrially may be accumulated by fish and shell-fish, and in man may cause severe neurological disorders, leading to death. Shell-fish which have fed upon blooms of certain algae, such as <u>Goniaulax</u> can accumulate neurotoxins poisonous to man. With the exception of the last-named, contaminants of this type are absorbed into the tissues of fish and shell-fish, and cannot be removed or destroyed by cleansing or heat treatment. The only preventive measures which can be taken are to avoid the discharge of effluents in the vicinity of shell-fish beds, or to prohibit the taking of shell-fish from areas where such discharges occur.

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